Your VIBROTEST

How to Make It Your Most Valuable Preventive Maintenance Tool

MP MASTER

MA30053

Insulation Resistance Testing:

- **SAFELY...**
- **QUICKLY...**
- **ACCURATELY**

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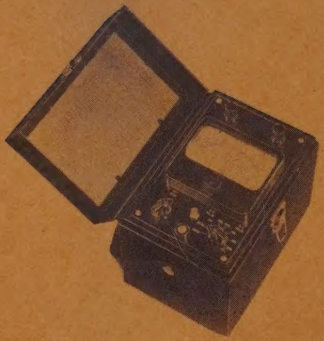


MODEL 204

Vibrotest with A.C. and D.C. voltage ranges, low-range ohmmeter

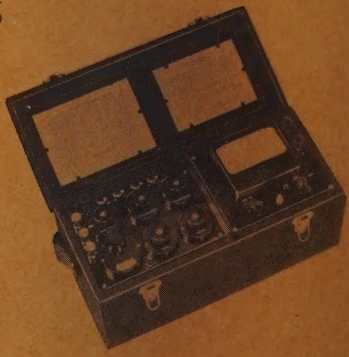
MODEL 218

Compact, low-cost Vibrotest with 0-100 megohm range at 500 volts, D.C. output.

TYPICAL VIBROTEST TYPES

MODEL 221

Vibrotest-D.C Voltammeter Combination, with low-range ohmeter.



MODEL 229

Vibrotest-Wheatstone Bridge Combination, with low-range ohmmeter.

YOUR VIBROTEST

This new, precision instrument of yours is the end product of years of research and thousands upon thousands of tests and reports in actual use. It is built to be used and used and *used.* The more you use it, the more ways you will find to make it help you . . . And you need not worry about wearing it out. Aside from infrequent battery replacements, the chances are good that it will demand nothing of you for years to come except the usual care in handling that any fine mechanism deserves.

ABOUT THIS BOOKLET . . .

Material in this booklet has been gathered from many sources with the intention of presenting a brief, plain-language description of all the basic types of testing possible with the versatile Vibrotest. It is not complete because new uses and new Models of the Vibrotest are continually being developed . . . But it should give you a working knowledge of how to make full, time-saving use of your Vibrotest.

Since space does not permit a model-by-model description of all Vibrotests, the Model 201 has been chosen as a typical instrument, having an ohm range and A.C. and D.C. voltage ranges in addition to its megohm range. Other Vibrotests operate in exactly the same manner as Model 201, so, regardless of the Model number of your instrument, the same procedures will apply.

Should you have a testing problem which is not covered in these pages, Associated Research engineers will welcome an opportunity to work with you toward its solution . . . Requests from other men working in plants, laboratories, ships, planes and trains throughout the world are responsible for the development of the present wide range of Vibrotest Models—and have made possible this compilation of Vibrotest operating data.

In the listing of specifications which follows on Page 48, only the more popular Models of the Vibrotest have been included. Additional models have been built for special applications. Inquiries are invited on any measurement problem which does not appear to be covered by the following listings.

TABLE OF CONTENTS

Note: A comprehensive subject index will be found at the back of the book, beginning on Page 42.

Page

Why Insulation Resistance Testing is Important..... 5

How Vibrotest Measures Resistance and Voltage...Ohms.. 6

Importance of Record Cards and Periodic Checking..... 9

Testing at Ambient Temperatures..... 13

VIBROTESTING

Where and What to Test..... 16

How to Prepare for Tests..... 18

Operation of the Vibrotest..... 18

Testing:

Wiring..... 23

Motors and Generators..... 27

Circuit Breakers..... 29

Switches..... 30

Insulators..... 31

Meters..... 31

Appliances..... 32

Transformers..... 33

Flooded Equipment..... 34

Network Testing..... 35

Dielectric Testing..... 37

Page

Inspection Testing..... 37

Dielectric Absorption (Capacitance Tests)..... 37

Vibrotest Maintenance..... 38

Index..... 42

Standard Vibrotest Specifications..... 48

Vibrotest Guarantee.....Inside Back Cover

ILLUSTRATIONS

Figure *Page*

1. Vibrotest Record Cards..... 11
2. Diagram of Distribution Panel..... 23
3. Diagram of Cable Test..... 24
4. Diagram of Ignition Harness Test..... 25
5. Diagram of D.C. Motor Test..... 26
6. Diagram of A.C. Motor Test..... 27
7. Photo of A.C. Motor Test..... 28
8. Diagram of Circuit Breaker Test..... 29
9. Diagram of Insulator and Switch Test..... 30
10. Diagram of Appliance Test..... 32
11. Photo of Transformer Test..... 33
12. Vibrotest Record Card of Flooded Equipment..... 35
13. Photo of Switch Network Test..... 33

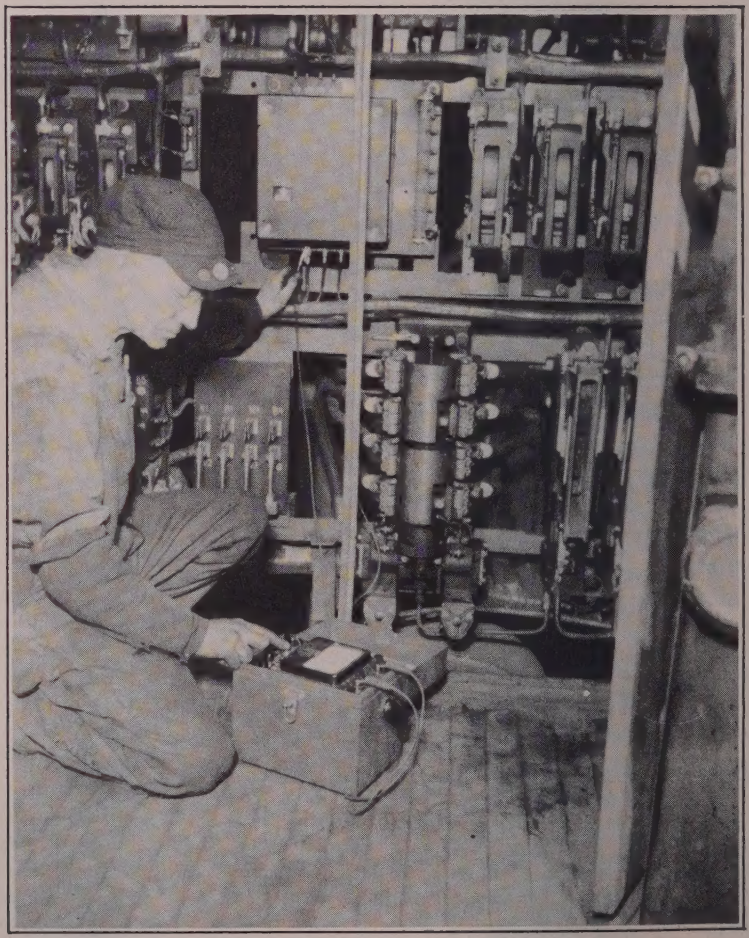
A. Photo of Panel..... fly

B. Photo of Under Panel..... 47

C. Photo of Battery Compartment..... 47

D. Wiring Diagram..... fly

E. All Vibrotest Models..... 48



Vibrotesting Circuits On Diesel Electric Locomotives

WHY INSULATION RESISTANCE TESTING IS IMPORTANT

Insulation covering the various pieces of electrical equipment and wiring in your plant or product is, to the eye, inert. Its dielectric properties (resistance to electrical flow) are the reason for its use; and since good dielectric materials are also generally good wearing materials, the problem of weakening or faulty insulation resistance may easily be disregarded until valuable equipment or critical wiring systems fail in use.

Actually, electrical insulation is subject to severe stresses, even under normal operating conditions. These stresses, which cause progressive weakening of insulation value, are caused by heat, dirt, moisture, vibration, wear, aging, and even by light. An electric motor operating cycle gives a good example of these stresses. When the cold motor is started, its insulation is also cold. As the motor heats, so does the insulation, expanding under the temperature rise, and contracting when the motor is shut off. You have seen the vast power exerted by ice freezing in a confined space—bursting iron pipes or automobile radiators and engine blocks as though they were paper. This same force is present, in varying degrees, in any heated-and-cooled material; and creates strains on insulation that can eventually result in breaks which cause direct short circuits or serious power losses.

Dirt is one of the greatest enemies of insulation because almost all casually collected dust, lint, airborne grease, etc. is an excellent conductor, and capable of penetrating minute cracks and faults in electrical insulation. Keeping all electrical equipment clean is a primary rule of good preventive maintenance—and Vibrotesting is the best means of detecting hidden dirt in electrical machinery and wiring which is causing insulation deterioration.

Again with a motor as an example, let us assume that it operates in a damp atmosphere, such as encountered in many processing plants, paper mills, and the like. When it is started, the rising temperature allows the air around it to absorb more moisture; and a part of this moisture is absorbed by the insulation in the windings. On cooling, some of this moisture condenses on the insulation, and aids the expansion-contraction effects in deteriorating the insulation. Even a damp, high-humidity day creates this effect, lowering the insulation resist-

ance of all electrical equipment—as you will discover when you Vibrotest your equipment on such a day. Of course, flooding or other accidental immersion of electrical equipment calls for special treatment in drying and cleaning. Data on techniques for handling flooded equipment will be found on Page 34.

Vibration is an ever-present hazard wherever there is operating machinery, steam lines, or even heavy pedestrian traffic. Insulation is subject to the same results from vibration as the old automobile that "actually shook itself to pieces."

Wear, aging and light deterioration are generally less severe than damage caused by dirt, water, heat and vibration . . . And all of them operate relatively slowly, but nonetheless surely, in electrical insulation.

Because of these natural "enemies" of insulation, periodic checks with Vibrotest will almost invariably predict the breakdown or dangerous weakening of any part of your electrical systems, or any piece of equipment. More data on periodic checking . . . how to do it . . . when to do it . . . what to look for . . . is given under the heading *Importance of Records and Periodic Checking* on Page 9.

Vibrotesting of components, sub-assemblies and completed units during processing, manufacturing and final assembly is of equal importance. Often, time and money can be saved by detecting insulation faults before shipment.

HOW VIBROTEST MEASURES RESISTANCE . . . VOLTAGE . . . OHMS

Your Vibrotest is so easy to use, so accurate, and so dependable that it is unnecessary to go into technical details of its operation . . . But knowing how it gets the results you want may be of assistance to you in finding even more time- and cost-saving uses for it than are listed in this little book.

One of the greatest advantages of Vibrotests is that most Models have test circuits which enable you to do complete testing on most electrical wiring and equipment without the necessity of carrying any other instrument. Megohms . . . ohms . . . A.C. and D.C. volts . . . are all at your fingertips to help you do a job that leaves no doubt as to the condition of your equipment.

Because Vibrotest employs a torque-type instrument movement (i.e., springs are always under tension), the instrument can be used in any position. No leveling is necessary. It is so rugged that even ordinary vibration does not affect it. Only one hand is required for operation.

MEGOHM RANGES

The megohm range on your Vibrotest gives you a direct reading of the millions of ohms of resistance which any electrical insulation offers to the passage of current. Actually, even good insulation *does* allow current to pass, if only on the order of 0.000001 ampere, or less, per 1,000 volts of impressed potential. This passage of a minute current through insulation makes the Vibrotest operate. When you set the selector on the megohm range, connect leads to the object to be tested, and press the push-button, you can hear a faint hum inside the instrument. This is the vibrator in operation, and when you hear it, there is a potential of 125 to 1,000 volts (depending on your Vibrotest Model) between the leads. This voltage causes a current to flow through the insulation and the indicating meter of the Vibrotest which is calibrated directly in megohms. Thus, you read resistance value as a result of the primary electrical formula: $E = IR$.

High voltage across the Vibrotest terminals is built up from the three volts supplied by two No. 6 dry cells, connected in series. This is accomplished by changing the battery direct current to alternating current by means of a synchronous vibrator, stepping up the A.C. through a transformer to the desired high voltage, then rectifying the transformer output to secure D.C. at the test terminals.

Note: Whenever you handle the Vibrotest—or allow others to use it—remember that there is a high voltage across the terminals when testing in the megohm range. Very low current flow makes the Vibrotest relatively safe, even when improperly used; but it is best to be sure no one will inadvertently come in contact with test circuit.

VOLTAGE RANGES

A.C. and D.C. voltage ranges built into the Vibrotest are highly accurate, and are read on the same scale as the ohm and megohm ranges, using the same two leads for all tests. Voltage ranges are selected on the single selector switch, and are placed in such a position as to be most convenient for testing circuits before switching to the ohm or megohm ranges. Both A.C. and D.C. voltage ranges have a resistance of 1,000 ohms per volt. A.C. voltage ranges have an accuracy of $\pm 2.5\%$ of full scale on sine-wave 60-cycle service. D.C. voltage ranges have an accuracy of $\pm 2\%$ of full scale value. Both voltage ranges are temperature compensated.

OHM RANGES

For measuring relatively low resistance values, one or more ohm ranges are available on most Vibrotest Models, powered directly by the three-volt dry battery source. This provides an easy means of determining the resistance or continuity of circuits in motors, relays, control box coils, and the like. Having an ohm range in your Vibrotest eliminates the necessity to carry or maintain a separate ohmmeter. In general, ohm ranges have been selected to provide as wide a coverage in resistance readings. In the Model 201 particularly the 2,000 ohm range was included because of its usefulness in general plant testing.

GUARD CIRCUIT

When testing insulation resistance where the humidity is high, or a large amount of moisture is present, considerable difficulty can be experienced unless the testing instrument is guarded against surface leakage across the instrument panel and across the internal measuring circuit. All Vibrotests employ an internal guard circuit which prevents any surface leakage from entering the instrument indicating circuit, so that true readings are obtained under the worst conditions of humidity and moisture, safely.

For all ordinary insulation resistance testing, an internal guard circuit is sufficient. Therefore, on Model 201 Vibrotests, and other Models up to 1,000 megohms, full scale, no external guard

terminal is employed. On all Models 1,000 megohms and above, or on Models to be used specifically for cable testing, a separate guard terminal is supplied so that the external equipment may be guarded as well as the internal circuit of the Vibrotest.

"Guarding" as used here, simply means that precautions are taken to insure that the true resistance of the circuit being measured for insulation resistance is the value recorded by the instrument; and that possible leakage paths, either through the instrument circuit, or across insulation *not* being tested are effectively prevented from entering the measuring circuit.

An example of external guarding is shown in Fig. 3, Page 24, depicting the testing of a cable. A piece of bare wire is wrapped over the braid to intercept any surface leakage currents between the conductor being tested and the lead sheath. Similarly, external guarding can be used on insulators, etc. where the resistance between the conductor and ground is being determined. A bare wire wrapped around the circumference of the insulator will prevent surface leakage errors.

DISCHARGE RESISTOR

To protect you against accidental shocks from capacitance discharges where there are capacitors in the circuit being Vibrotested, all Vibrotests incorporate a discharge resistor. This resistor is so connected that when the push-button is released, the resistor is automatically placed across the output instrument terminals, thereby dissipating any charge which might have been built up in the circuit under test. This exclusive Vibrotest feature is entirely automatic, requiring no manual switching or other attention to insure capacitance discharge.

IMPORTANCE OF RECORD CARDS AND PERIODIC CHECKING

Unlike voltage, circuit resistance, or current flow, which can be determined positively at any given time with proper instruments, insulation resistance values which are "safe" for any given piece of equipment vary greatly. Two motors, for example, of the same horsepower, same maker, and same age, may have quite radically different insulation resistance values, yet both be in safe operating condition. Therefore, insulation resistance tests can do the best

preventive maintenance job only if accurate records are kept on each piece of equipment tested; and tests are made at uniform intervals under similar conditions of operation, temperature and humidity.

This may sound complicated, but it resolves itself into a simple, fast job when Vibrotest Record Cards are used for each piece of equipment.

RECORD CARDS TELL THE "CONTINUED" STORY

On the Vibrotest Record Cards which came with your instrument (supplied with general purpose instruments only) one side is a graph form, having space at the top to identify the device for which the card is being made, and other pertinent data about it. The graph's horizontal lines show Vibrotest ohm readings from tests taken at dates which should be written in across the top of the graph. The five columns across the card may each represent a year, or some shorter period, depending upon how often tests are made. By plotting each test on this graph, and joining the test reading points with a line, an accurate history of the insulation resistance value of that particular device will be accumulated. Many Vibrotest users also draw a red line along the megohm value which they consider to be a safe minimum for each device, thus showing at a glance how close the Vibrotest readings are to the danger point. How to determine safe minimum insulation resistance values is discussed on Page 13.

On the reverse side of the Vibrotest Record Card are columns for recording pertinent data about the tests plotted on the graph. This information is important because of the variations which occur in insulation resistance readings under specific conditions at the times tests are made. If found impossible to duplicate testing conditions from one test to the next, the correction factor formulas on Page 14 will make possible the determination of equivalent values for every Vibrotest reading.

Following are several "stories" told by periodic Vibrotest readings on various devices. They will show how Vibrotesting works to save time and prevent failures in equipment.

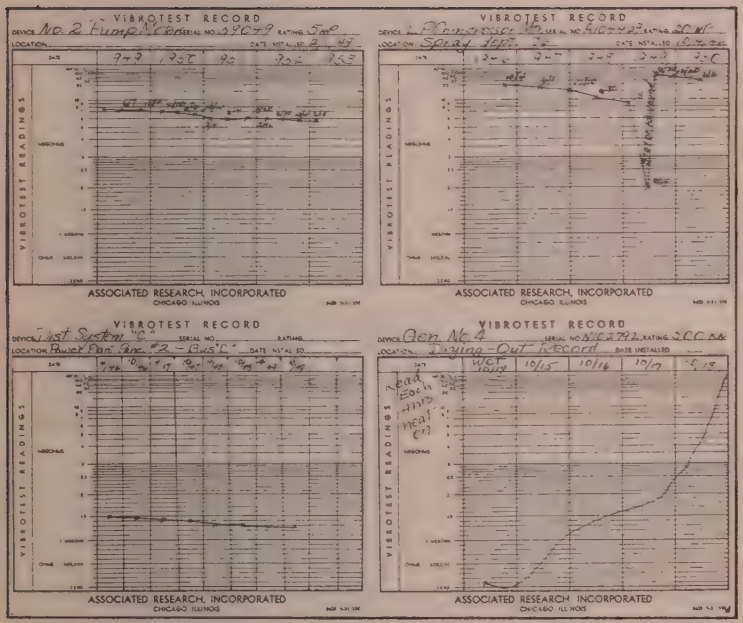


Figure 1—Insulation Story told by Vibrotest Record Cards

Figure 1, Record Card "A" tells the continued story of a hard-working motor that is aging normally. Note that the first reading of 7.5 megohms was taken when the motor was installed new. Later readings, taken at approximately equal intervals of four months, show a gradual, expected decrease in insulation resistance; but with no sudden drops that would indicate trouble in the offing.

Record Card "B" tells the story of trouble with a happy ending. This motor was performing satisfactorily for the first two years, when a periodic check showed a sharp drop in insulation resistance to very close to the danger line. Inspection showed a need for new stator windings, and after they were installed, resistance values bounced back higher than the first readings taken.

Record Card "C" is what we call a System Card. It shows the insulation resistance value of a whole network of motors, starters, automatic controls and wiring. This type of record provides a quick check of a group of equipment, and is widely used to see whether any element of the system may have taken a turn for the worse between periodic checks of individual circuits and pieces of equipment. A significant drop in the insulation resistance curve on a System Card calls for individual Vibrotesting of each piece of equipment in the network until the ailing unit is located and repaired. Detailed information on setting up equipment in networks for system testing is on Page 35.

Record Card "D" tells the story of putting a flooded motor back to work. It is a short-term card, made during the drying-out process, and will be supplemented with a regular periodic record card after the motor is replaced in service. Basic data on drying out motors begins on Page 34.

These cards are but a few examples of how to keep track of the condition of all types of electrical apparatus, and foresee trouble ahead in time to arrange for cleaning or repairs without disruption of operations with a sudden, unexpected breakdown.

Record Cards are available in envelopes of ten each and one envelope is normally supplied with most models. When ordering additional cards specify Part 8435.

WHAT IS "GOOD" INSULATION RESISTANCE?

Safe insulation resistance in rotating machinery or other equipment may be regarded as that which is high enough to permit the equipment to operate normally . . . without excessive current consumption or heating. This is the simplest, most obvious rule to follow if you do not care to go into the formulas which may be applied to electrical apparatus to get a close approximation of what the insulation should be for safe operation. Generally, you can consider any insulation satisfactory in industrial equipment and circuits operating at 1,000 volts or less if its resistance exceeds one megohm at normal operating temperatures and humidities.

THE ONE MEGOHM PER 1,000 VOLTS RULE

Carrying the safe minimum of one megohm per 1,000 volts a bit further, you can figure safe minimums for apparatus operating in excess of 1,000 volts by simply adding one megohm to the safe minimum for every 1,000 volts or fraction thereof. For example, if you have equipment operating at 2,500 volts, 2.5 to 3.0 megohms minimum resistance readings should be satisfactory. If your initial insulation resistance readings fall below this "rule-of-thumb" minimum, equipment should be taken out of service, inspected carefully, and necessary cleaning or repairs made to brings resistance values over the minimum reading required.

ACCEPTABLE RESISTANCE VALUES ACCORDING TO CURRENT FLOW

Given below is a table showing minimum acceptable insulation resistance values for equipment or circuits operating at various rates of current flow. These values apply to insulation resistance between conductors, conductors to ground, and motor or generator connections to the frame.

Operating Current in Amperes	Acceptable Minimum Insulation Resistance in Ohms
5	2,000,000
10	1,000,000
25	400,000
50	250,000
100	100,000
200	50,000
450 or higher	25,000

TESTING AT AMBIENT TEMPERATURES

Most insulating materials are affected in inverse proportion to the temperature at which they are being operated. This means that if you test a motor cold and get a satisfactory insulation resistance value, there is no assurance that the value will be safe at the operating temperature of that motor unless you correct for the change in resistance due to the temperature rise which occurs

when motors go to work. The following formula will permit you to test motors, or other apparatus which operate above ambient temperatures, when they are cold—yet get a close approximation of what the insulation resistance value will be at normal operating temperatures.

$$\text{Log} \quad R_2 = \log R_1 - \frac{(t_2 - t_1)}{N}$$

where R_2 = unknown insulation resistance in megohms at temperature t_2.

R_1 = known insulation resistance in megohms at temperature t_1.

N = constant which is equal numerically to the degrees Centigrade change in temperature for a ten to one change in insulation resistance. (Value of N will vary from 20 to 100, with the factor usually occurring between 30 and 60 for most insulating materials.) In the case of motor windings, a Class A alternating current winding can be assumed to double its resistance for each 9° C. drop in temperature. Therefore N = 30. In Class B A.C. insulated windings, insulation doubles for each 18° C. drop in temperatures. Therefore, N = 60. Direct current windings can be assumed to double for each 12° C. temperature drop. Thus, N = 40. The above-mentioned temperature constants may be used for normal commercial calculations. However, if extreme accuracy is desirable, it will be necessary for you to set up an exact constant and establish a curve for each piece of equipment.

For example, if you have a direct-current motor which operates at 80° C. (176° F.), and you test it at room temperature of 20°C (68° F.), to get an insulation resistance of 37.6 megohms, the formula works out:

R_1 = 37.6 megohms
t_2 = 80° C.
t_1 = 20° C.

Note: to convert degrees Centigrade to degrees Fahrenheit: $^\circ C = \frac{5}{9}(^\circ F - 32)$ and $^\circ F = \frac{9}{5}(^\circ C + 32)$.

N (for D.C. windings) $= 40$

Log $R_1 = 1.57519$

Log $R_2 = 1.57519 - \frac{(80 - 20)}{40}$

$= 1.57519 - 1.50000$

$= 0.07519$

$R_2 = 1.19$ megohms

As you can see, the high "cold reading" of 37.6 megohms drops to what might be a dangerously low value of 1.19 megohms when corrected for temperature rise. The fact that high humidity would further lower this value probably should lead to a decision to remove this motor for cleaning and careful inspection.

SHORTCUT TO COLD TESTING

A shortcut many Vibrotest users take where they find it necessary to test motors cold is to figure the formula backward to secure a minimum cold reading value which will insure safe insulation resistance at operating temperatures; thus:

Assume a minimum value for R_2 as 3.0 megohms, with the same conditions as in the example above.

Then: $\text{Log } R_1 = \text{Log } R_2 + \frac{(t_2 - t_1)}{N}$

where $\text{Log } R_2 = 0.47712$

$t_2 = 80$

$t_1 = 20$

$N = 40$

$\text{Log } R_1 = 0.47712 + 1.50000$

$= 1.97712$

$R_2 = 94.87$ megohms

Now, instead of drawing the red "safe minimum" line on the motor Record Card at 3.0 megohms, the red line is drawn in at 95 megohms, and subsequent tests made at the same (within 4° C. or 7° F.) cold temperature, with closely approximate relative humidities.

RECOMMENDED PRACTICES

For additional information on the subject of insulation resistance testing we recommend publications of the following organizations: American Institute of Electrical Engineers, 33 West Thirty-ninth Street, New York 18, N. Y., request bulletin No. 43, April 1950, entitled "Recommended Practice for Testing Insulating Resistance of Rotating Electrical Machinery." This bulletin contains a great deal of valuable information on synchronous, induction, and direct-current machine testing which it is impractical to reproduce in this booklet. American Standards Association, 70 E. 47th St., New York 17, N. Y.; American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

TEST VOLTAGE RELATION TO OPERATING VOLTAGE

At times, insulation develops weak spots, which, under full working load and voltage may have a tendency to cause serious current leakage or actual insulation breakdown. If the test voltage applied in making insulation resistance tests where this weakness exists is too far below the actual working voltage, there is a possibility that the test reading will appear satisfactory when it actually is not. Therefore, where you find it necessary to test equipment which normally operates at voltages exceeding the Vibrotest test voltage, it is well to increase the minimum value of acceptable resistance 1.5 to 2.0 times that of equipment operating at voltages lower than the test voltage. (See also: *Dielectric Strength Testing,* Page 37.)

WHERE AND WHAT TO TEST WHEN YOU START VIBROTESTING

When you begin insulation resistance testing, every *unit* of current-carrying apparatus should be tested and a Vibrotest Record Card made of the test reading. To define what constitutes a unit for insulation resistance testing, let us assume the simplest possible motor operating circuit to consist of power input wiring, a hand-operated, double-pole single-throw switch, the wiring between switch and motor, and the motor itself. Since the power input wiring will be a part of the general wiring, we

will not consider it as a part of this example. Then, the switch is the first component which may cause trouble due to insulation failure. But since the motor has several different circuits in which the insulation can fail, the easiest solution is to consider the switch and wiring from it to the motor as one unit; the motor alone as another unit. Thus, by a simple analysis of where insulation failure can occur, and how to make any potential failure easiest found, we arrive at a definition of testing units for record purposes.

Keep your test units as simple as possible, so that when trouble develops, you can locate it quickly. The extra effort necessary to disconnect various sections of grouped equipment for testing will be well repaid when weakened insulation shows up in a unit which will require only two or three tracing tests to pin down the source of potential trouble.

When you do not have records established, yet suspect that a piece of equipment may have weakened insulation resistance, you can get immediate information as to the condition of the unit by testing for its Polarization Index. Instructions for determining Polarization Index are on Page 38.

TEST WORKING EQUIPMENT FREQUENTLY

Working electrical equipment, such as motors, generators, transformers, heating elements, relays, etc. is almost invariably more likely to develop insulation failure than wiring, insulators and other non-moving, non-cycling electrical apparatus. Therefore, your schedule of periodic insulation resistance tests should include more frequent testing of the working equipment. Four to six months between these tests is generally considered the safe maximum. Some users of the Vibrotest check all rotating machines every three months; and there are many motors operating in dirty or moist atmospheres which are checked monthly. Tests of wiring and like apparatus are usually adequate on a yearly basis unless working conditions are particularly bad.

VIBROTESTING IS PREVENTIVE MAINTENANCE AT ITS BEST

During the past few years, the number of companies who have instituted extensive preventive maintenance programs is proof enough of the economic value of this relatively new servicing concept. Insulation resistance testing is a major item in successful preventive maintenance—and your Vibrotest is the fastest, easiest, most accurate instrument available for this purpose.

VIBROTESTING

HOW TO PREPARE FOR TESTS

Shut Down. Take equipment or circuits to be tested out of service. Check between equipment and ground on Vibrotest voltage ranges to be sure no A.C. or D.C. voltage to ground exists. If possible, disconnect all leads to unit to be tested. Where a motor or circuit is not completely isolated, make sure you know all the components which will be tested when you connect the Vibrotest. Should you overlook an interconnected circuit, the Vibrotest reading will be lower than expected, and may cause you to take equipment out for cleaning or repair that is actually in good working order.

OPERATION OF THE VIBROTEST

Open the case of your Vibrotest and look it over carefully, using the accompanying photo-diagram (Figure A on back fly page) to identify the various items and establish their functions firmly in mind. You can use the operating instructions in the lid for making tests, but it is suggested that you FIRST read the following section carefully, since these expanded instructions are not limited by space considerations, and are intended as a general introduction to Vibrotesting, as well as actual operation directions.

You can remove the entire cover of your Vibrotest by opening it fully, then working it gently, push the cover toward the top of the instrument, while holding on to the body of the instrument. The pin hinges slide out of their sockets in the case, and leave a compact instrument, ready for use.

OPERATING SKILL SAVES TIME . . . GETS POSITIVE RESULTS

Before connecting leads to terminals (1) to begin actual testing, we suggest that you practice operating your Vibrotest for several "dry runs" to become familiar with the use of the selector switch (4), the push-button (3), and the "Set Zero" knob (6). These are the controls you will soon be using almost automatically, and proper habits learned now will save you time and insure accurate results later.

As a starter, turn switch (4) to the extreme counterclockwise position marked "Megs." With your right forefinger, depress push-button (3) *halfway*, and you will see the meter needle run over near the extreme right side providing set zero knob (6) is up slightly from its full counterclockwise position which is an off position. It is important—and may take a little practice—to depress the push-button the right amount. If you do not depress it far enough, the instrument will not be energized. If depressed fully, to the test reading position, the needle may give erroneous readings if it has not been properly "zeroed" previously. Try using the push-button until you can make the needle go to "0" on the meter without difficulty. Should the meter needle not come to rest exactly on "0" on the megohms scale with the push-button halfway down, move the "Set Zero" knob with your left hand in the direction you want the needle to move in order to rest on "0." After you have the meter zeroed, pushing the button all the way down puts the correct test potential across the terminals, and you read megohms resistance directly on the scale, using black figures. Without the leads connected to a circuit, the resistance across the terminals is, of course, infinity—and the needle will go directly to the "∞" mark at the extreme left of the scale.

Try it a few times. . . . Gets faster and easier right away, doesn't it?

You will hear the vibrator hum as soon as you press the push-button halfway down when in the "Megs" range. This is a signal that the instrument is operating, and a warning that there is a high potential across the lead terminals. If you hear no vibrator hum, see Page 39 for instructions.

Now try the same procedure, but with the selector switch (4) in the "Ohms," or extreme clockwise position. Ohm readings are

taken on upper scale using both black and red figures. You notice that you cannot switch directly from "Meg" to "Ohms." This is another built-in Vibrotest safety device to warn you to *always check your test circuits for voltage before testing for either ohms or megohms.* Turning the switch through the voltage ranges is a simple, mechanical reminder which can save you a lot of time and trouble even when you are rushed or thinking about other problems.

A hint here to add to the efficiency of your Vibrotesting: Make it a habit, beginning right now, to leave the selector switch on one of the high voltage ranges between tests, and when the Vibrotest is not in use. If you do this as a part of the simple testing routine, the instrument cannot possibly be energized accidentally—and it is then automatically ready for the first step in your next test.

DIRECTLY-CONNECTED VOLTAGE RANGES

When you test for voltage with Vibrotest, *do not press the push-button.* Any voltage in the circuit will register immediately on the meter when the selector switch is turned to one of the voltage ranges. When testing D.C. voltages, be sure polarity is correct . . . otherwise, you may damage the meter movement. In case you are not certain of D.C. polarity, or whether the apparatus is A.C. or D.C. operated, commence testing with the highest voltage range, dropping the range where necessary to get the best reading. D.C. checked on A.C. ranges will produce one small movement of pointer, likewise A.C. on D.C. range will do the same.

Voltage values for both A.C. and D.C. ranges are in black figures below the meter scale.

MEGOHM TESTS

Here is the step-by-step procedure to make megohm tests. After a little practice, you should be able to set up the instrument, make the test and proceed to the next piece of equipment in less than two minutes—allowing a full sixty-second test period:

1. Set selector switch to highest available voltage range A.C. or D.C.

2. Attach leads to terminals: red lead to "+" terminal; black lead to "—" terminal.

3. Attach lead clips to equipment to be tested. (Remember that you are trying to determine the resistance value of insulation between current-carrying and non-current-carrying or grounded components. See table of contents page 3 for list of test diagrams.

4. Check connection for voltage to ground, by working down thru voltage ranges. If voltage is present, determine its source and eliminate it before attempting to check insulation resistance. NEVER START A MEGOHM TEST UNTIL THERE IS NO EXTERNAL VOLTAGE IN THE TEST CIRCUIT.

5. Set selector switch on "Megs."

6. Press push-button halfway down, and set meter needle on zero (extreme right) with "Set Zero" knob.

7. Depress push-button all the way down, and start timing test. Unless you are testing for capacitance or for polarization index, a 60-second test will, in most cases, be adequate to give a good indication of insulation resistance values. Should you be making tests with different lengths of time for different pieces of equipment, enter test time on the Vibrotest Record Card.

8. Take megohm reading in black figures above meter scale. When push button is released any capacitive charge in circuit is dissipated thru discharge resistor.

9. Take temperature and humidity reading and enter on Record Card, with megohm reading together with date of test. If you find it impossible to keep accurate records of temperature and humidity, an approximation of equivalent test conditions can be made by taking tests on a given piece of equipment as nearly as possible at the same time after it has been taken out of service, and with closely similar atmospheric conditions. This method of Vibrotesting is not recommended because of the difficulty of judging humidity accurately. However, if the apparatus is located where humidity remains fairly constant, due to processing or other circumstances which tend to stabilize normal atmospheric humidity variations, you can probably achieve fairly accurate results.

10. Move selector switch to high-voltage range.

11. Disconnect leads.

OHM TESTS

Follow megohm testing procedure, Steps 1 through 4, then:

5. Set selector switch on "Ohms."
6. Depress push-button halfway, and set meter needle on zero (extreme right) with "Set Zero" knob.
7. Depress push-button fully, read ohms resistance value on meter top scale, using both red and black figures.
8. Move selector switch to high-voltage range.
9. Disconnect leads.

SOME TESTING TROUBLES VIBROTESTING SAVES YOU

If you have used any other type of insulation testing instrument, you may think we have left out some of the necessary instructions for your Vibrotesting. Here are some of the things you DON'T have to do:

NO LEVELING—Your Vibrotest operates perfectly in any position—even upside down or in motion!

NO CRANKING—Vibrotest's all-electric circuit not only eliminates laborious hand cranking, but also assures you of a steady, uniform testing voltage.

NO WAITING! When you are ready to test, the push-button brings you instant response . . . no pause to grind up to operating voltage.

NO PUZZLES about which binding posts to use . . . the two Vibrotest terminals are used for *all* tests on *all* instrument ranges. On instruments designed for use where external guarding is desired, a third terminal is supplied marked "Guard" (see Guard section page 8 for details).

NO COMPLEX CALIBRATION for any Vibrotest ranges . . . Instant calibration checks are possible at any time—and corrections easily made.

VIBROTESTING SPECIFIC EQUIPMENT

While the basic principles of Vibrotesting are the same for all types of equipment, the following diagrams and brief descriptions will show you how to determine insulation resistance quickly and easily in various types of electrical apparatus.

Wiring

Vibrotesting of wiring can be done on all types of systems if you keep two precepts in mind:

1. Be sure your wiring is de-energized.
2. Know what wiring is included in the test . . . *and make a record card of it.*

Where you have a distribution panel, you can check the whole system to ground by attaching one Vibrotest lead to the dead post of the open main power switch; and the other lead to grounded conduit. Figure 2.

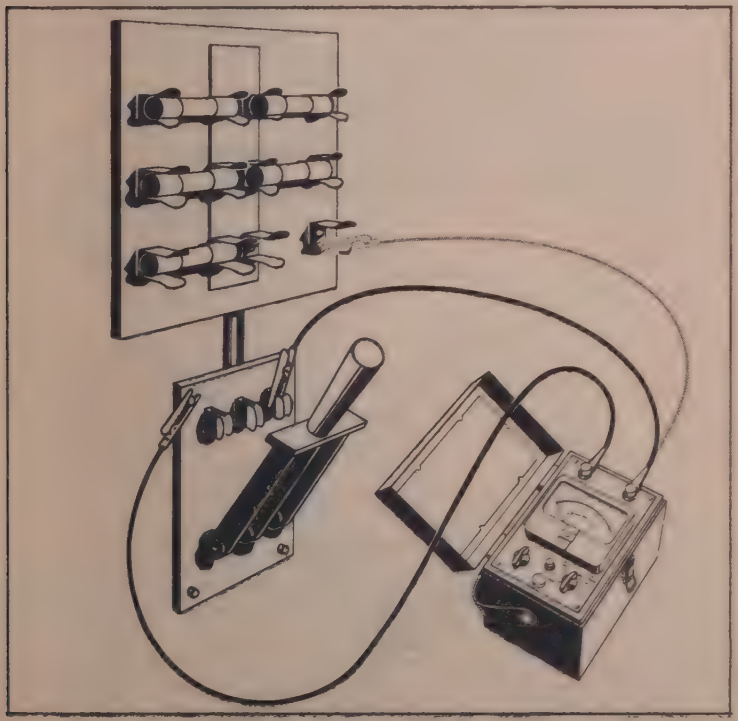


Figure 2—Vibrotesting a distribution panel and its individual circuits

Individual circuits are tested to ground by opening distribution panel switches or fuses and testing each circuit in turn (Figure 2 shaded lead).

Multi-conductor cables may be Vibrotested in any of the ways shown in Figure 3. The drawing depicts the measurement of insulation resistance between wire (3) and lead sheath (5). Various other measurements can be made such as wire to ground (1, 2 and/or 3 to 6), wire to wire (1, 2 or 3 to any combination of each other), wire to braid (1, 2 or 3 to 4), wire to sheath (1, 2 and/or 3 to 5). See Guard Circuit Section Page 8 for use of center guard terminal shown as shaded line.

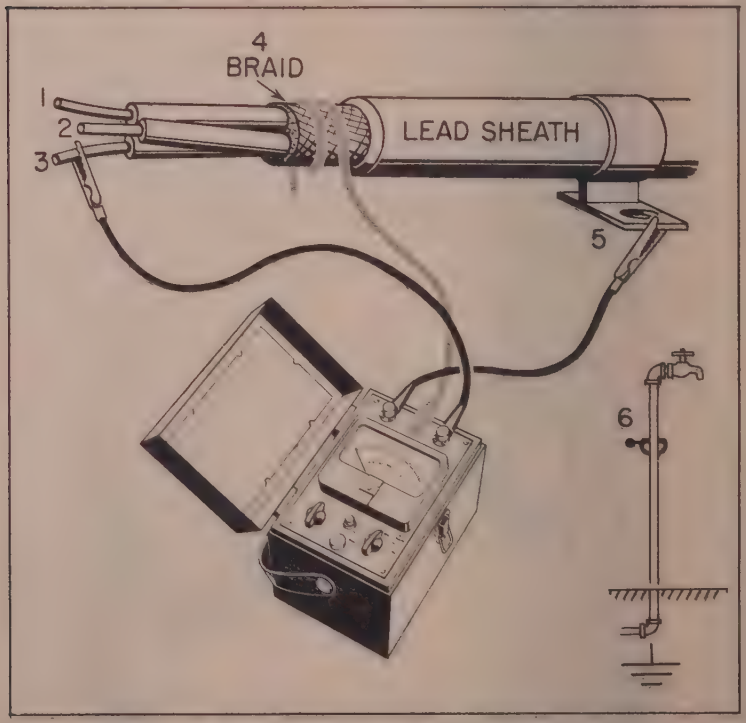


Figure 3—Vibrotesting multiple conductor cables

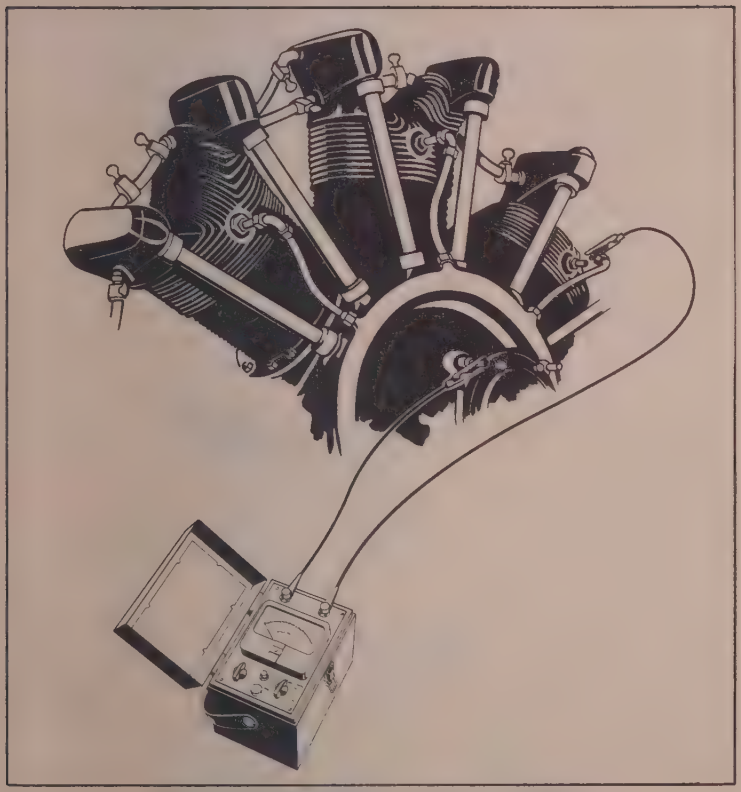


Figure 4—Vibrotesting Ignition harness

It is well to remember that when you Vibrotest wiring which is connected to any panel or equipment, there may be appreciable leakage between terminals which will show up in your tests as lowered insulation resistance. If your original record cards were made with panels connected, continue future tests in the same manner.

The effectiveness of an ignition system not only depends on spark plug condition but upon the condition of the harness as well. By checking each wire to ground, any insulation deterio-

ration will be noticed by a drop in resistance which if not remedied may mean faulty firing of that cylinder. The trouble may be traced to the distributor or magneto or associated components. In a similar manner, each spark plug may be checked for fouling. The Model 241 Vibrotest has been especially designed for ignition harness tests and features a color coded scale with complete accessories.

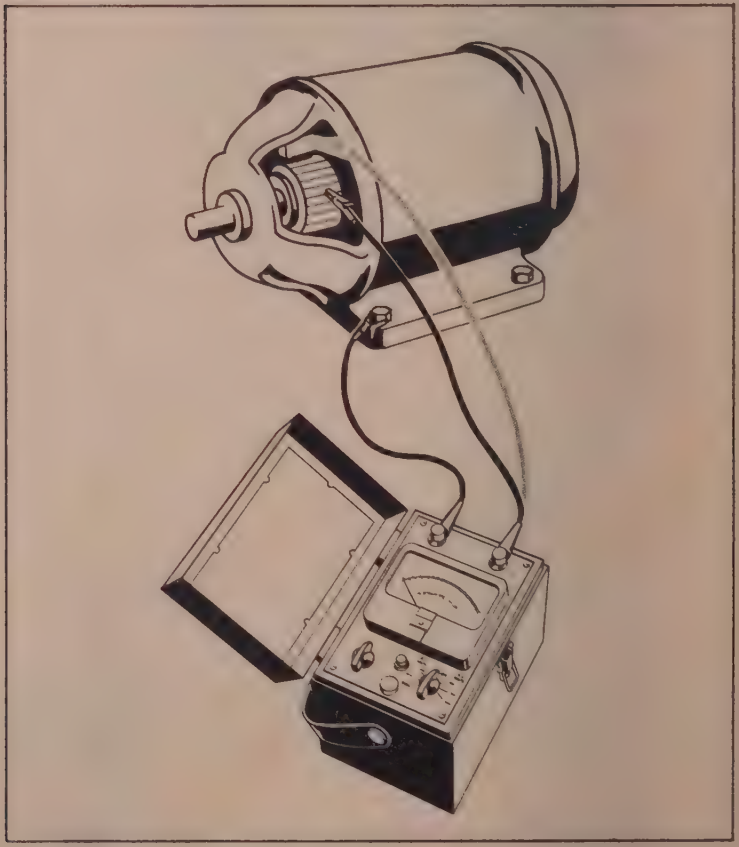


Figure 5—Vibrotesting Direct Current Motors and Generators

D.C. Motors and Generators

Disconnect the unit from its power source or line load and attach the negative terminal of the Vibrotest to the motor ground, with the positive terminal connected to the brush rigging. This test gives the overall resistance of all components of the unit. To read the resistance of the insulation of the field, either remove the brushes or lift them free of the commutator ring and support them by means of a suitable insulator. With the brushes lifted free of the commutator ring, connection of the Vibrotest leads to ground and to one of the brushes will give the resistance of the field alone (see Figure 5.) With the brushes still removed from the commutator ring, connection of one of the Vibrotest leads to one of the segments of the commutator and the other to ground of motor frame will give the insulation resistance of the armature alone. This may be repeated for all segments of the commutator.

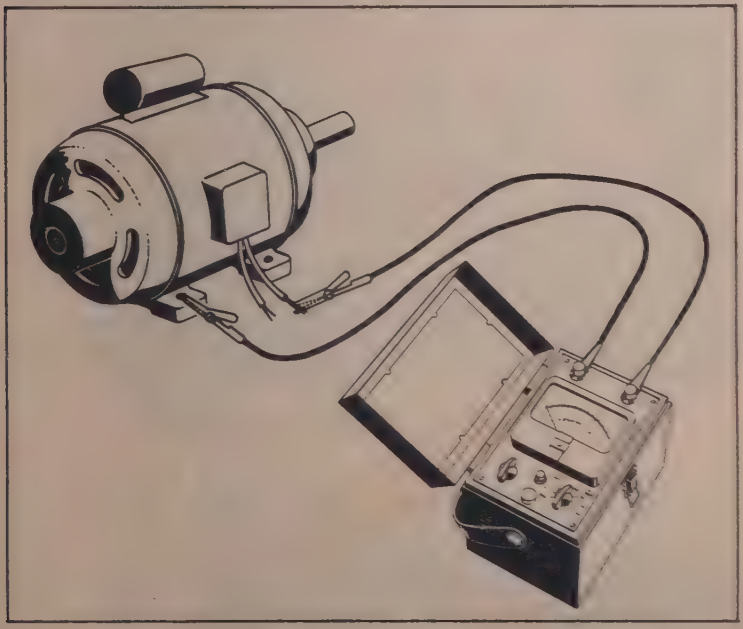


Figure 6—Vibrotesting Alternating Current Motors

A.C. Motors

First disconnect the motor from the line, either by use of the switch or by disconnecting the wiring at the motor terminals. If the switch is used, remember that the insulation resistance of the connecting wire, switch panel and contacts will also be read at the same time. Best test is to connect the positive Vibrotest lead

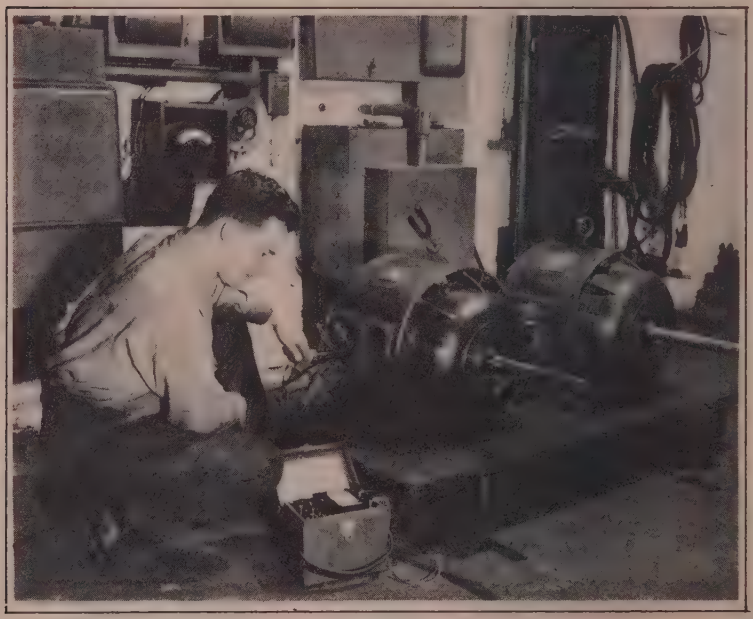


Figure 7—Checking the voltage to ground of a motor

to the motor line, and the negative lead to the frame of the motor. (See Figure 6 and 7.) If insulation resistance minimums have been established, your reading may be checked against them. If you are setting your own safe standards, use the data beginning on Page 12 under "What is 'Good' Insulation Resistance" to determine whether the motor is in safe operating condition.

Circuit Breakers

After disconnecting the circuit breaker from the line, check each terminal to ground, placing the positive Vibrotest lead at the terminals in turn. Next, open the breaker and test insulation resistance between terminals: one Vibrotest lead on each terminal. If your breakers are of the oil type, dirty oil may be causing leakage currents through the breaker even when it is open. In dry types of breakers, dirt or grease in the mounting may be causing

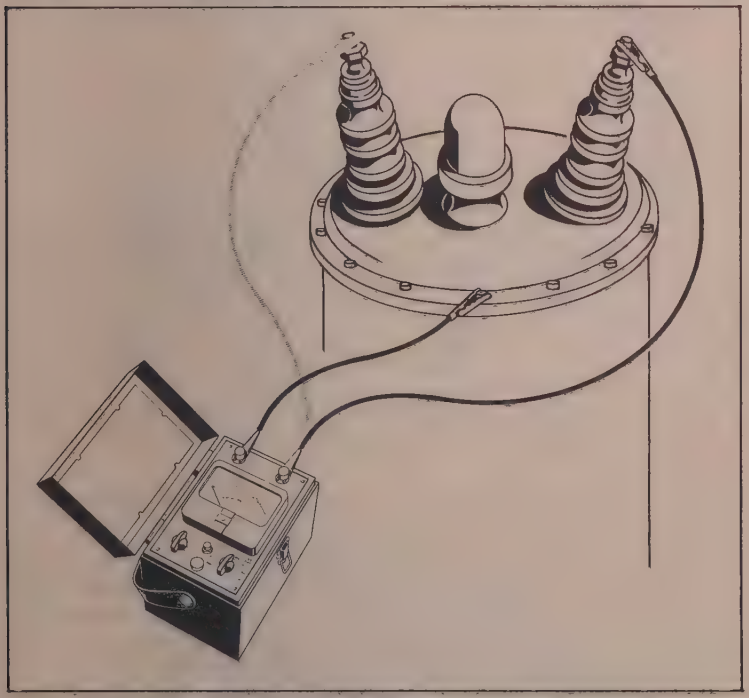


Figure 8—Checking circuit breaker insulation resistance

leakage. Figure 8 depicts the measurement of insulation resistance between either circuit breaker terminal to ground. This measurement should also be made between terminals.

Switches

Switches should be *completely* disconnected from line and relay wiring before Vibrotesting. (See Figure 9, right half.) Where manual switches are being tested, make tests both from ground to terminals, and between terminals. Switches with safe insulation are a vital part of any electrical system, and so deserve your careful

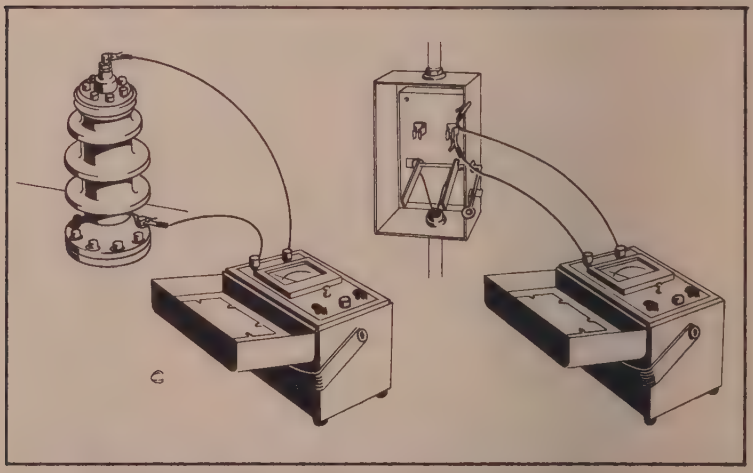


Figure 9—Vibrotesting insulators and switches

Vibrotesting attention. When you are testing electrically-operated switches, check the insulation of the coil or coils and contacts which operate the switch. For coils, test first with one Vibrotest lead to one of the coil leads, the other to ground. Next, test between coil lead and core iron, or solenoid element. If relays are involved, make your Vibrotest check with one lead attached to the relay plate or contact, and the other lead to the coil-core or solenoid contact. These suggestions may appear to be excessive in view of the usually-superior performance over long periods of time of most switches. . . . They are made here on the theory that one inoperative closed switch may literally wreck a whole plant system. Vibrotesting thoroughly can help to insure you against such an occurrence.

Insulators

Insulators, the "forgotten men" of electrical systems, are subject to several ills that can make them a potential hazard unless they are periodically Vibrotested. Breakage is probably the first hazard with insulators. Casually accumulated dirt, grease or liquids is another. Rarely, faulty construction makes a brand new insulator a source of danger. To Vibrotest your insulators, connect Vibrotest leads to each end; then test each end to ground. (See Figure 9 left half.) Where insulators do not have suitable electrical contacts, wrap the ends with foil before testing.

Capacitors

You can use your Vibrotest to check both insulation resistance and approximate capacitance of capacitors. When you connect leads to capacitor terminals, observe polarity carefully. Time your test until meter needle stops moving upward, then record insulation resistance at highest reading. Dividing test time, in seconds, by 15 will give you the approximate capacitance, in microfarads, of the capacitor. If the needle has a tendency to waver toward the high reading, then drop back down the scale, the capacitor may be leaking, and further testing is indicated. Be especially careful to *release push-button* before starting to disconnect test leads from capacitors. If you do not give the Vibrotest discharge resistor an opportunity to dissipate the stored potential in the capacitance, you may get a severe shock.

Meters

When testing insulation resistance of meter movements and cases to ground, disconnect leads to meter and connect Vibrotest positive lead to each terminal of the meter in turn; having negative Vibrotest lead connected to a suitable ground.

Meter movements themselves are generally so delicate that if you suspect leakage between elements in the meter, it is best to remove the meter and have it checked by an instrument repair expert.

Watthour meter connections to terminal boxes should be checked from each terminal to ground after opening power circuits and removing meter from terminal box. Insulation resistance between terminal connections should then be checked to determine possible leakage.

Most watthour meters are the property of local utilities, and are sealed to prevent tampering. However, if you have watthour meters in your plant which are installed to record localized power usage, there are simple means of checking their insulation resistance with your Vibrotest. It is recommended that if you have meters under your responsibility, you contact the manufacturer, requesting circuit diagrams and data on connections to make insulation resistance tests of watthour-meter power coils, rotors and damping magnets.

Appliances

Virtually all home-used appliances are operated by people without an intimate knowledge of electricity—and often without awareness of the extreme danger they may risk through faulty appliances . . . whether the danger arises through their own negligence, or through manufacturing practices. Vibrotesting of all appliances at the factory is one of the most important single precautions against merchandise returns due to unit failures, and home accidents caused by short circuits, burn-outs, or circuit

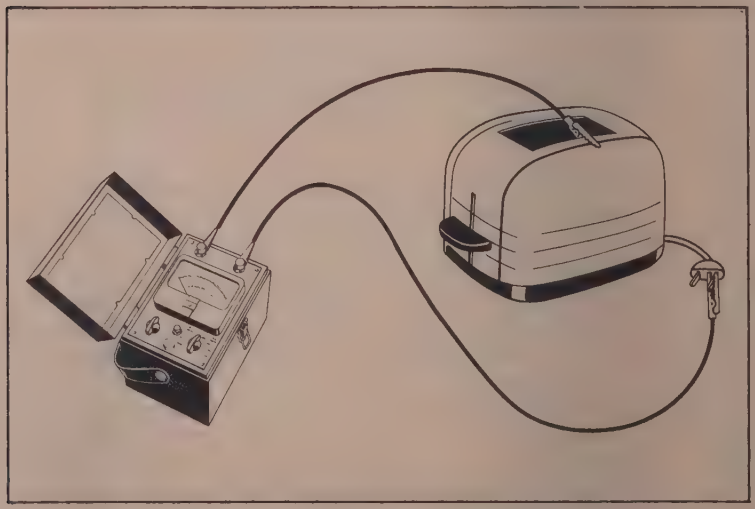


Figure 10—Vibrotesting appliances

failures. Figure 10 depicts the testing of a toaster. This same test can be made to other appliances by arranging the test leads in similar manner. Such Vibrotesting, where used in final inspection of various common household appliances, have already shown up thousands of faulty units which might have caused lawsuits—or death—had they been allowed to reach consumer markets.

Transformers

Disconnect leads from both primary and secondary windings. Vibrotests can be made of either the primary or secondary winding individually by connection of the Vibrotest negative lead to an associated ground (case, metal mounting, or manmade ground), and the lead from the winding under test to the positive lead of the Vibrotest. Following Vibrotests of each winding, it is a good idea to test insulation resistance between the windings themselves. Connect one Vibrotest lead to the primary (either

Figure 11—Vibrotesting transformers

lead); and the second Vibrotest lead to the secondary. (See Figure 11.) All of these Vibrotests, under proper identifying labels, should be recorded on the Vibrotest Record Card.

If you have transformers with multiple-voltage windings, the procedures above should be followed to test all windings to ground, and each winding's insulation resistance value to every other winding.

Flooded Equipment

When your electrical equipment is watersoaked—either by flood waters or accidental wetting—you are fortunate indeed when you have Vibrotest Record Cards on the ailing equipment. First, clean and dry equipment manually to the best of your resources. Then, depending upon what has been flooded, begin the recommended electrical or mechanical drying-out procedure. As soon as it appears that actual dryness is approaching, make your first Vibrotest and record it on a new Record Card which is "red-lined" at the insulation resistance value you last read from your Vibrotest before wetting occurred. This initial reading will give you a good idea of how "wet" the equipment still may be. Depending upon this reading, make additional readings at regular intervals until the insulation resistance is approximately equal to the previous dry value. After this point has been reached, it will be safe to put the equipment back on line providing that the last "dry" reading showed safe insulation resistance. Wetting of any kind, serious enough to require unusual drying measures, should be recorded on the permanent Record Card of the equipment affected, and the "Drying-Out Card" kept on file for reference.

Where no previous Vibrotest Record Card has been made on flooded equipment, readings should be made at intervals during the drying-out procedure until a definite "plateau" occurs in the insulation-resistance value line on the card. Such a line is plotted as shown here. (Figure 12). After the plateau stage of drying-out has been reached, Polarization Index tests should be made (see Page 38) until an Index of 2.0 or more has been reached. If equipment will not come up to the figure above, repair or overhaul is indicated.

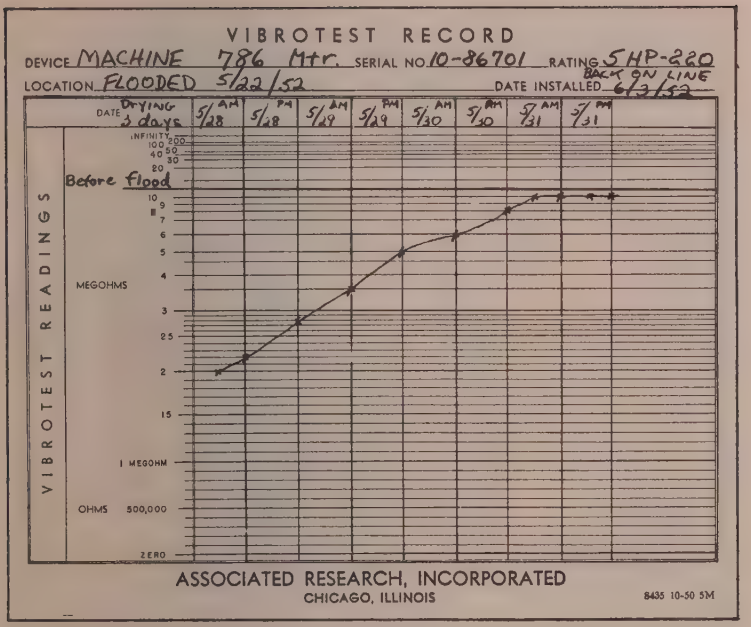


Figure 12—Record card of flooded motor during the "dry-out" process

Network Testing

Network testing—with adequate Vibrotest information on the components of any network—provides a quick method of determining the serviceability of the system. Once you have determined that all parts of the network have safe insulation resistance values, Vibrotest from a main distribution point and record the value. Then make and record values of individual circuits which make up the network. With this basic insulation resistance information on Record Cards, you will be able to check the whole network at frequent intervals without the necessity of disconnecting each piece of equipment. Only when a significant lowering of the network insulation resistance appears will it be necessary to "work backward" through individual circuits, then

Figure 13—Network testing

individual units to locate faulty equipment. Figure 13 shows the testing of an entire de-energized system. A record of this measurement when compared with previous measurements denotes the condition of the network to determine if any segment is defective and should be isolated for maintenance.

Dielectric Strength Testing

Testing for dielectric strength of insulating materials is a job for another line of Associated Research precision instruments: "Hypot" High Potential Dielectric Strength Testing Instruments. These instruments are built in three series to cover virtually the entire range of high potential testing requirements, from "Hypot" Juniors (no larger than your Vibrotest), with ranges as low as 0-1,500 volts testing potential at 80 VA, to the big Series 500 Mobile "Hypots" with testing ranges up to 50,000 volts at 5 KVA.

Full information on "Hypots" will be sent to you promptly upon request. If possible, tell us what your dielectric strength testing problem is, so that we can be of assistance to you in making specific suggestions as to the "Hypot" best suited to your needs.

Inspection Testing

Insulation resistance testing of hundreds of different components in industry has resulted in setting up Vibrotest standards in inspection testing to protect manufacturers from the possibility of shipping out defectively-insulated products. Using the Vibrotest as an inspection-testing instrument does not vary in any respect from regular preventive maintenance tests, except that the use of the Vibrotest is usually almost continuous—and generally in one place. Continuous use in inspection testing has only proved more thoroughly the long life of all major Vibrotest components . . . and the practicality of using Vibrotests under severe service conditions.

DIELECTRIC ABSORPTION

Dielectric absorption is the actual "soaking up" of electrical current by the insulation being tested. When making standard, sixty-second Vibrotests, you will note that the meter needle is rising slowly during the test. This is the dielectric absorption gradually increasing the insulation resistance, and may be combined with capacitance charging of the apparatus being tested.

Using Dielectric Absorption in Vibrotesting

You can make use of dielectric absorption in Vibrotesting to determine the condition of apparatus where no insulation resistance testing records exist by the "1 to 10" test, or finding the "Polarization Index" of the apparatus.

Polarization Index

Determining the polarization index of any piece of apparatus is simple: Connect the Vibrotest, and commence timing a 1-minute test. Record the resistance reading at one minute *but continue to hold the push-button down* (or let a small weight hold it down for you), and extend the total test time to 10 minutes. The reading at the end of 10 minutes, divided by the reading taken at one minute gives you the polarization index.

For instance, if your one-minute reading on a motor is 30 megohms and the ten-minute reading 80 megohms, the polarization index will be $\frac{80}{30} = 2.67$.

Generally, a polarization index over 2.0 indicates good insulation—provided, of course, that the one-minute reading exceeds the safe minimum for the apparatus. In practice, a good polarization index is almost always accompanied by a one-minute test reading well above minimum.

VIBROTEST MAINTENANCE

BATTERIES

Your Vibrotest is powered by two No. 6 dry cells connected in series to deliver 3 volts to the instrument circuit. Until the voltage output drop to 2.1 volts, you will be able to zero the meter needle satisfactorily and make tests with full accuracy. When you cannot zero the needle, it is time to replace the batteries.

Remove screws A-A-A-A Figure A (back fly sheet) on sides of top flange and lift out the entire panel, which will also include the protective cover over the instrument components under the panel. Figure C (2). As shown in the Figure C, the batteries are held in the bottom of the case by a clamp secured by screw (3).

Remove screw and clamp (3) and batteries (1). Remove wiring and connect new batteries in series, being sure to observe polarity: the red wire from the instrument case goes to the center post of one battery; the black wire to the outside post of the other battery. Jumper wire connects from one minus post to the other plus post.

Replace batteries in case and clamp down, making certain that tops of battery posts are at least one inch from the end of the instrument case.

Replace panel and A screws.

VIBRATOR

When you press the push-button halfway down in the megohm range and hear no vibration hum, and the needle does not go to zero, change selector switch to ohms range and see if needle can be zeroed. If not, see *Batteries* above. But if you can zero in the ohms range and not in megohms, a new vibrator may be required.

Remove screws B-B-B-B (Figure A) and lift out panel without protective cover. The vibrator is the plug-in metal cylinder shown in Figure B (1). It can be replaced simply by pulling gently but firmly to remove old vibrator and plugging in new one . . . making sure that socket holes and vibrator pins match without forcing. Check to see that old and new vibrators have the same part number.

INFINITY NEEDLE SETTING

When de-energized, the meter needle on your Vibrotest should rest directly over the "∞" mark at the extreme left of the scale. If you find that the needle does not take this position, carefully turn set screw in the center of the meter case until the needle is properly positioned.

FUSE

The fuse Figure A (5) protects your Vibrotest against excessive voltage or current entering through the test terminals. Should the fuse blow, remove it by unscrewing the black milled cap and replace from spares clipped to the under side of inner lid (10) in Vibrotest cover.

ACCIDENTAL DAMAGE

Despite rugged construction throughout, your Vibrotest will not stand heavy blows, dropping, or shocks without the possibility of damage to the meter movement or parts of the circuit.

Should you have the misfortune to damage your Vibrotest, the quickest and most economical way to get it back to work for you is to send it to Associated Research, Incorporated, 3758 West Belmont Avenue, Chicago 18, Illinois, for repairs and prompt return. Pack the instrument carefully in carton or box, with enough protective cushioning such as excelsior or paper to prevent damage in transit. For fastest service, ship prepaid by Railway or Air Express, insured for full value.

At the time of shipment, send complete repair information and authority to Associated Research Incorporated either by letter or purchase order giving the following information:

1. Model and Serial Number.
2. Defect noted.
3. When and How the instrument was or will be shipped (waybill number if possible).
4. Address to send invoice.
5. Address to return instrument.

All repairs are on a time and material basis, F.O.B. Chicago, Illinois with terms to credit approved firms, net thirty days.

TROUBLE FOR TINKERERS

It has been our experience that when a Vibrotest has been damaged and someone attempts home-made repairs, the final result is usually a much larger repair bill than would have been necessary if the instrument had been sent to us in the first place. Vibrotest circuits and components are painstakingly assembled with the finest materials available. Substitution of stray parts is almost certain to lead to trouble.

If, for any reason, you cannot send your Vibrotest to us for repairs, find the best instrument repair service near you, and insist that any parts replacements be made with genuine Vibrotest components . . . You will *never* "wear out" your Vibrotest—and we want you to get the full service and accuracy that are built into it.

A.C. POWER PACK

An alternating current Power Pack, for use on 110-volt, 60-cycle A.C. lines is available for all Vibrotest Models. The Power pack can be substituted for the batteries when the instrument remains in one place—as in production testing—or where the use of the regular battery power source is impractical for some reason. The Vibrotest Power Pack fits inside the battery case, with the power cord coming through the instrument case at the right side.

LINE OPERATED VIBROTESTS

Some Vibrotest models feature an electronic circuit in place of the battery operated vibrator power supply. While the test procedures are the same as with battery operated models, special operative instructions are shown on the instruction card and repair information shown for battery operated models will have to be modified.

PANEL MOUNTING

All Vibrotest Models can be furnished for panel mounting.

INDEX

A.C. Machinery 28
A.C. Power Pack 41
A.C. Voltage Range 8, 20
Absorption, dielectric 37
Acceptable insulation resistance values 13
Aging, effect of 5
Appliances, Vibrotesting 32
Batteries, Vibrotest 38
Beginning Tests 16

Cable, Vibrotesting:
- Multi-conductor 24
- Sheathed 24

Calibration, Vibrotest:
- Infinity 39
- Zero 19

Capacitance measurement 31
Capacitors, Vibrotesting 31
Cards, Record 9

Direct Current:
- Generators 27
- Motors 27
- Voltage tests 20

Damaged Vibrotest 40

Dielectric:
- Absorption 37
- Materials testing 37

Directions, Vibrotest:
- Maintenance 38
- Operation 18
- Testing 18

Dirt, effect on insulation 5
Drying-out tests 34
Engineering Service 1

Flooded equipment 34
Formulas, cold testing 15
Fuse, Vibrotest 39
Frequency of tests 17
Generators:
A.C. 28
D.C. 27
"Good" Insulation Resistance 12
Guarantee ..... Inside Back Cover
Guard Circuit 8
Heat Effects 13
How to Prepare for Tests 18
Humidity, effects of 5
Hypots 37
Ignition Harness tests 25
Infinity calibration 39
Inspection testing 37
Insulation:
Dielectric:
Absorption 37
Strength 5, 37
Stresses 5
Insulation Resistance:
Definition 5
Dielectric Absorption 37
Polarization Index 38
Records 9
Tests 16
Insulators, Vibrotesting 31
Instruments (Meters) 31
Interpreting Vibrotest Results 10
Leakage:
Guards against 8
Surface 8
Leveling unnecessary 22

Maintenance:
Preventive 18
Vibrotest 38
Megohm Ranges:
Operation of 7
Testing in 20
Vibrotest Models 48
Meters, Vibrotesting 31
Methods:
Operating Vibrotest 18
Record Keeping 9
Test procedures 18
Models, Vibrotest 48
Moisture, effects of 5
Motors, Vibrotesting:
A.C. and D.C. 27, 28
Needle setting:
Infinity 39
Zero 19
New equipment tests 38
Network Vibrotesting 35
Ohm Range:
Operation 8
Tests 22
Vibrotest Models 48
One-Megohm-per-thousand-volts Rule 13
Operation, Vibrotest (See "Vibrotest")
Panel-mounted Vibrotests 41
Periodic Tests 17
Polarization Index 38
Preparing for tests 18
Preventive Maintenance 9, 18
Problems, Vibrotesting 1
Protection, Vibrotest:
Guard circuit 8
Discharge resistor 9

Ranges, Vibrotest 48
Recommended practices 16
Record Cards 9
Rectifier in Vibrotest 7
Repairs 40
Shock hazard 9
Special Vibrotests 50
Specifications, Vibrotest 48
Standards for testing 16
Surface leakage 8
Switches, Vibrotesting 30
Temperature:
  Effect of 5
  Correction for 13
Test:
  Ambient temperatures 13
  Cold, Shortcut to 15
  Conditions 13
  Frequency 17
  Importance 9
  Insulation resistance, importance of 5
  Problems 1
  Procedure 16
  Recommended Practices 16
  Time 31, 37
  Voltages 16, 48
  Where and What 16
Variation in readings 13
Vibration, effects of 5
Vibrotest:
  How it works 6
  Maintenance:
    Batteries 38
    Damage 40
    Fuse 39
    Needle setting (infinity) 39

Trouble for tinkerers..... 40
Vibrator..... 39
Megohm ranges..... 7
Models..... 00
Ohm ranges..... 8
Operation..... 18
Megohms..... 20
Ohms..... 22
A.C. volts..... 20
D.C. volts..... 20
Panel mounting..... 41
Specifications..... 48
Voltage ranges..... 7

Vibrotesting:

A.C. machinery..... 28
Appliances..... 32
Capacitors..... 31
Circuit Breakers..... 29
D.C. motors and generators..... 27
Flooded equipment..... 31
Frequency of..... 17
Ignition harness..... 25
Importance of..... 5
Insulators..... 31
Meters..... 31
Networks..... 35
Preparation for..... 18
Transformers..... 33
Watthour meters..... 31
Wiring..... 23
Waiting time..... 22
Wear, effects of..... 5
Wet equipment tests..... 34
Wheatstone Bridge Models..... 49
Where and What to test..... 16
Why Vibrotest?.....5, 22
Wiring tests..... 23

Zero calibration:

Megohm scale..... 21
Ohm scale..... 22
Volt scales..... 39

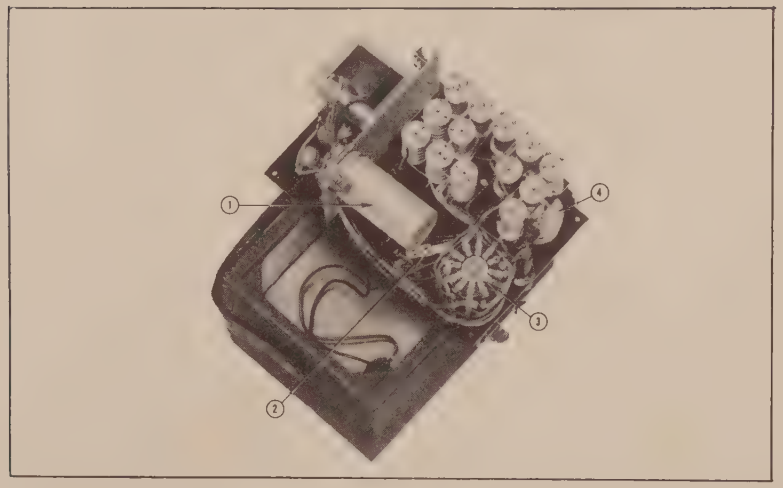


Figure B—Under panel view of Model 201 Vibrotest

1. Vibrator
2. Push button switch
3. Range selector switch
4. Zero set potentiometer

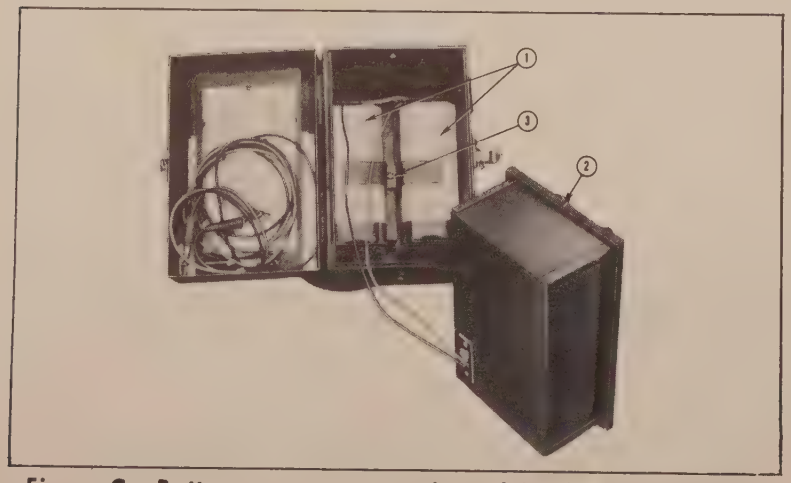


Figure C—Battery compartment view of Model 201 Vibrotest

1. Batteries
2. Panel with protective cover
3. Battery clamp with set screw

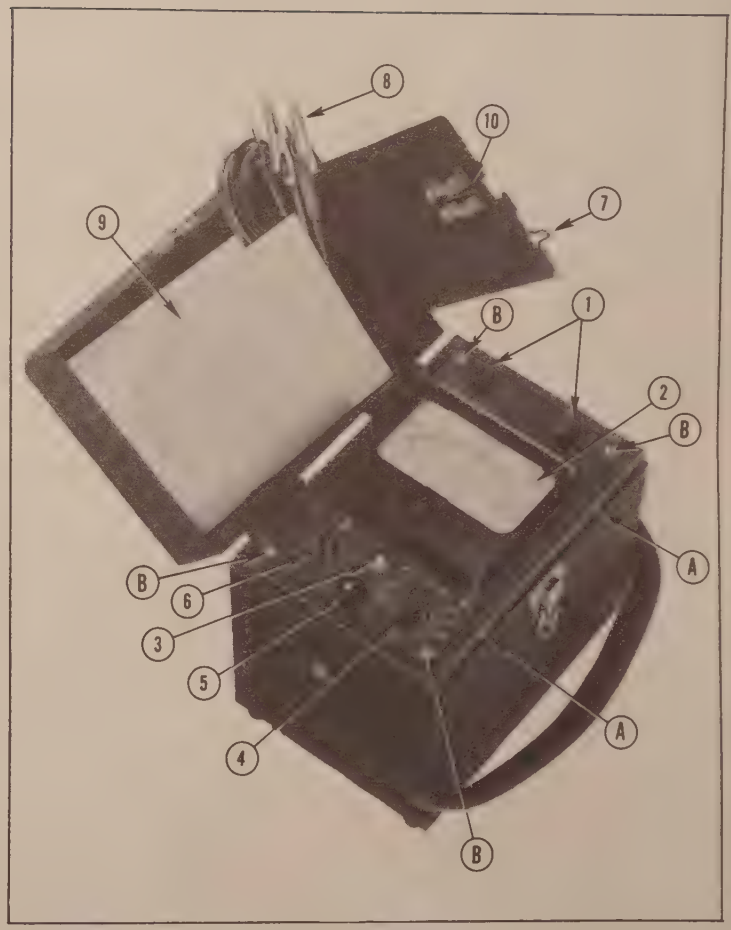


Figure A—Model 201 Vibrotest, panel and accessory compartment

1. Terminals
2. Meter
3. Push button
4. Range selector knob
5. Fuse post
6. Zero set
7. Inside compartment catch
8. Test leads
9. Vibrotest record cards
10. Spare fuses

A—side screws
B—panel screws

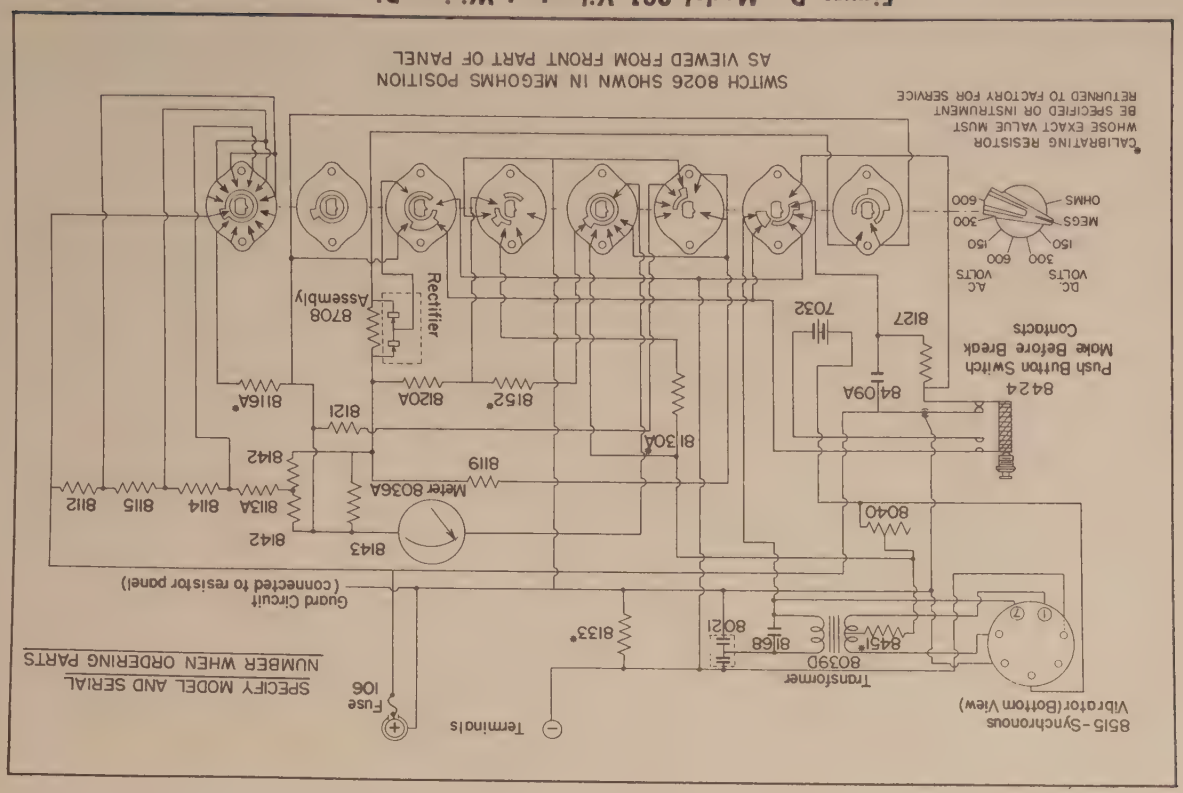


Figure D—Model 201 Vibrotest Wiring Diagram

GENERAL PURPOSE

Model	Test Volts D.C.	Megohm Range 0 to—	Ohm Range 0 to—	Volt Range A.C. 0 to—	Volt Range D.C. 0 to—
201	500	200	2,000	150–300–600	150–300–600
204	1,000	200	2,000	150–300–600	150–300–600
205	500	200	20,000	150–300–750	150–750–1500
206	500	200	2,000	15–150–300	15–150–300
208	500	200	2,000 200,000	150–300–600	150–300–600
209	500	200	2,000 200,000	15–150–300	15–150–300
210	500	200	2,000	150–300–750	150–300–750
211	1,000	200 2,000	200,000		
212	1,000	100 1,000	100,000		
213	500	100 1,000	10,000		
214	1,000	200	2,000	150–300–750	150–300–750
215	500	100 1,000	100,000		
216	125 500	20 200	20,000	150–300–600	150–300–600
217	1,000	200	2,000 20,000	150–300–750	150–300–750
218	500	100			
220A	500	200	2,000 20,000 200,000		
224A	500	100 1,000			

Figure E—Table of All Vibrotest Models

227	500	200	2,000 20,000 200,000	150–300–600	150–300–600
232	500	200	20,000	150–300	30–150–300
233	500	200	20,000	150–300–600	30–150–300
240	500	1,000			
247	500	50			
248	1,000	25–5000			
264	500	100	10,000		
265	500	50	10,000		

VIBROTEST VOLTAGE—CURRENT COMBINATIONS

Model	Test Volts D.C.	Megohm Range 0 to—	Ohm Range 0 to—	Voltage D.C. 0 to—	Amperes D.C. 0 to—
221	500	200	2,000	30–150–300	3–30–300
231	500	200	2,000	30–150–300	3–30–300–750
239	1,000	200	2,000 20,000 200,000	30–150–300	3–30–300

VIBROTEST WHEATSTONE BRIDGE COMBINATIONS FOR MURRAY & VARLEY LOOP TESTS

Model	Test Volts D.C.	Megohm Range 0 to—	Ohm Range 0 to—	Wheatstone Bridge Range	Decade Range
223	1,000	200	2,000	.001–9,999,000	1–9999
225	500	100		.001–9,999,000	1–9999
229	1,000	100 1,000	100,000	.001–9,999,000	1–9999
230	500	1,000	10,000	.001–9,999,000	1–9999

SPECIAL PURPOSE MODELS

Model	D.C. Test Volts	Megohm	Description
241	1000	0–2,000	For Ignition Harness Tests
266	500	1–100 10–1,000	Uniform test potential battery operated instrument
269	with color-coded scales		For measuring resistance of conductive materials in accord with Natl. Fire Protection Bull. #56 (June 1952).

ACCESSORIES (Specify Vibrotest Model)

8170	Fabric carrying case
8171 or 8199	Leather Carrying Case
8435	Vibrotest record cards
8033	Five foot test leads

GUARANTEE

Your Vibrotest is unconditionally guaranteed against defects in material or workmanship for one full year from date of delivery. Any instrument found defective under this guarantee will be repaired or replaced free of charge when returned to our factory prepaid. This guarantee does not cover batteries or vacuum tubes furnished with or used in Vibrotests; nor is it effective if the instrument has been tampered with or subjected to gross misuse. We do not assume responsibility for repairs made outside our factory.

"PRECISION INSTRUMENTS SINCE 1936"
OTHER ASSOCIATED RESEARCH
ELECTRICAL MEASURING INSTRUMENTS

HYPOT Portable

- High voltage tests for LEAKAGE, BREAKDOWN SHORTS
- Models with variable voltage up to 6,000 V.A.C.
- Sine Wave output
- SAFE to operate

Write for Bulletin 4A.

Mobile

- High capacity high voltage tests
- Models up to 30,000 V.A.C.
- BURN and TEST features
- Heavy duty construction

Write for Bulletin 5A.
D.C. outputs available.

VIBROGROUND

- For GROUND, SOIL & EARTH resistance
- Push button operated patented circuit
- Light weight, compact, rugged
- Seven Models available
- Not affected by the resistance of auxiliary prodes nor leads
- Accuracy not affected by stray earth currents or potentials
- Zero balance galvanometer
- Sensitive

Write for Bulletin 105.

PHASE SEQUENCE

For determining phase sequence on three phase circuits by two neon glow lights. Fits in hip pocket, weighs less than one pound. No moving parts.

Write for Bulletin 7A.

TACHOMETERS

Centrifugal and chronometric types in single or multi-range models up to 50,000 RPM. Furnished complete with accessories ready to operate.

Write for Bulletin 12AA.

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